Chapter 14
The Role of Sustainability Standards in the Energetic Use of Palm Oil Plantation Residues: Case Study of Cameroon

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14.1 Introduction

This chapter aims to discuss the sustainability aspects of using residual wood from plantations for the production of electricity and heat. There are continuous debates about the potential of biomass feedstock to help solve the numerous environmental problems related to the growth of global energy consumption we face nowadays. Political aims and commitments of individual firms are putting pressure on the limited biomass resources of the European Union. As a consequence, various options for importing biomass from countries outside the EU are being assessed for their sustainability and impacts on the climate.

For several years, the majority of politicians, economists and the public have considered bioenergy a solution to the climate crisis and the need to meet the increasing global energy demand. However, biomass as a renewable energy source has been recently discussed controversially. The many facets of biomass as an energy source have caused misleading assumptions and wrong judgments about its sustainability and its impact on the global carbon household. The ongoing debates

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about the negative impacts of biofuels produced from palm oil, soy and energy plants on the climate, local economies and international trade have lead to a review of the concept and strategy among politicians and society.

For biofuels and liquid energy carriers, the EU Renewable Energy Directive (RED) (2009/28/EG) provides criteria and requirements for the proof of a product's origin. For the use of solid and gaseous biomass for electricity generation and heating, in contrast, the European Commission has published recommendations and guidelines for sustainability criteria which are voluntary and have not yet been implemented into national law by any of the member states (IFEU 2011).

The purpose of residual biomass is its processing to wood chips or pellets and subsequent combustion in existing power plants, so-called *co-firing*. This technology is the process of replacing a share of fossil fuel supplied to a power station with a renewable alternative, such as solid biomass (Kaltschmitt et al. 2009).

The main focus of this chapter is the discussion of relevant criteria for the assessment of the sustainable production of wood chips or pellets and how these criteria are addressed by voluntary sustainability standards.

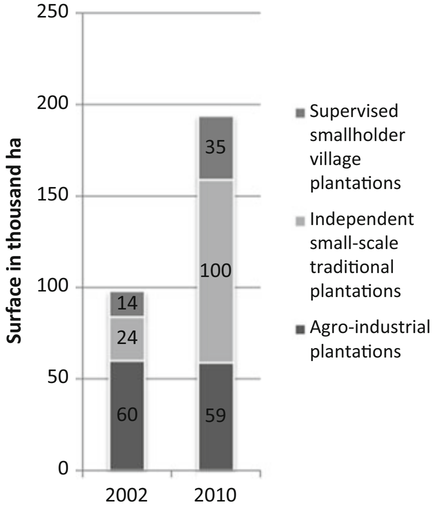
With this view, the chapter has the following objectives:

- Providing an overview of the available resources suitable for the production of solid biofuels on the basis of the Cameroon case;
- Identifying relevant criteria for sustainable energy production from woody organic residues; and
- Discussing examples of standards and certification schemes applicable to the specific case of imported energy wood.

In this context, this chapter supplements and continues the studies on voluntary sustainability standards in the palm oil and forestry sector by proposing their extension to cover aspects which are significant for the responsible use of plantation residues. The chapter starts by presenting the current situation of the palm oil industry and the related biomass accumulation in Cameroon. Section 14.3 discusses various sustainability aspects among which are ecological impacts and socio-economic considerations attributed to the energetic use of plantation residues. As part of the challenge of balancing greenhouse gas (GHG) emissions, the carbon dioxide emission reduction potential will be explained.

The chapter ends with conclusions and recommendations in Sect. 14.4, highlighting the most important criteria which need to be considered for possible future binding guidelines on the political and corporate level in order to ensure sustainable provision and use of solid biofuels.

Fig. 14.1 Development of area of palm oil plantations in Cameroon (adapted from Hoyle and Levang 2012; World Rainforest Movement 2006)

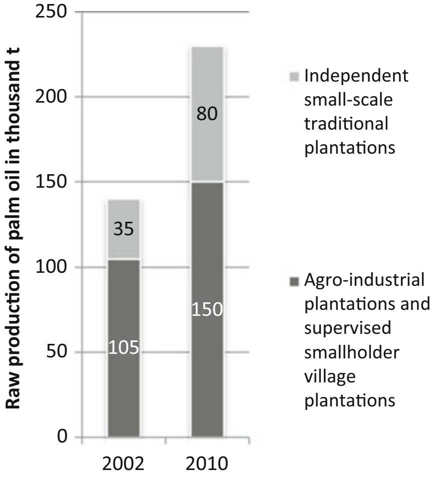


14.2 Oil Palm Residues in Cameroon and Their Energetic Potential

The apparent trend of increasing palm oil production in many African countries, e.g. Cameroon (Hoyle and Levang 2012), leads to a proportionately increasing amount of biomass on palm oil plantations. The following figures provide data on the surface extension (Fig. 14.1) and the development of oil palm production of three different plantation types (Fig. 14.2) which is necessary to estimate the amount of the available biomass and its energetic value.

The data show that the surface, and consequently the production of palm oil, has increased significantly over the past 10 years. Today, 194,000 ha of land in Cameroon are dedicated to oil palm cultivation (Hoyle and Levang 2012). While the total surface of palm oil plantations in Cameroon has almost doubled since 2002, the raw production of palm oil has risen by around 64 %. The largest area of oil palm plantations is in the hands of independent small-scale traditional plantations, which has also expanded the most. The respective area is now four times as large as it was in 2002. At the same time, the surface area of agro-industrial plantations has remained more or less stable. Despite the strong area expansion of independent small-scale plantations, their production of palm oil has not increased proportionately, implying a decreasing productivity of palm oil per unit area. Simultaneously, a productivity increase of agro-industrial plantations and smallholder village plantations can be concluded from the observation that palm oil production of these two types has increased more than the corresponding area. According to the data, the overall productivity has decreased from 1.43 t/ha in 2002 to 1.19 t/ha in 2012.

Fig. 14.2 Development of palm oil production in Cameroon (adapted from Hoyle and Levang 2012; World Rainforest Movement 2006)



Nevertheless, the trend towards a further expansion of palm oil production is obvious. An increase in production to 300,000 t in 2015 and 450,000 t in 2020 is proposed by the Government of Cameroon's Rural Sector Development Plan. This aim will be achieved mainly by increasing oil palm production, oil extraction yield and the area under production. The latter is more in the government's focus than the palm oil yield or any environmental or biodiversity concern. The Government of Cameroon plans to further promote industrial palm oil production as part of its growth, employment and poverty reduction policies. In order to meet domestic demand and for export purposes, palm oil production is a national priority. According to the 1994 New Agricultural Policy of the Ministry of Agriculture and Rural Development (MINADER), there was a need for increased investment in agro-industry through privatisation of existing public institutions and the creation of new agro-industrial palm oil plantations (Hoyle and Levang 2012).

Increasing amounts of biomass on palm oil plantations imply higher masses of residues, e.g. felled, old plants or palm kernel shells as a residue of the palm oil production process. Besides the availability of biomass, heating values are a decisive factor determining the suitability of organic residues for energetic purposes. The heating value of conventional wood sourced in Europe, for example spruce or beech, is 15 MJ/kg (air dry) (LWF 2011). In comparison, heating values of oil palm trunks (OPT) of around 17 MJ/kg (UNEP 2012) can easily compete with conventional raw material used for biofuel production. Consequently, plantation residues theoretically bear a relatively high potential for energy generation despite their high moisture content. Especially OPT are a suitable source of raw material for the production of wood chips or pellets because they account for almost half of all oil palm compartments available at felling after 25 years (UNEP 2012). Assuming similar values for the case of Cameroon, more than 9 million tonnes of OPT accumulate on the total area of plantations.

Bioenergy produced from palm kernel shells (PKS) could be one of the most promising alternatives because it does not involve costly extraction of biomass from the plantation site since it accumulates during the production of palm oil. This would imply lower potential impacts on soil fertility and consequential changes in fertiliser use. They already find use as boiler feed in palm mills (UNEP 2012) and have become a popular trading commodity and subject of research projects despite their relatively small availability compared to other residual products of the oil palm. Refining of raw oil palm biomass, e.g. pelletisation or torrefaction, can achieve even higher energetic values and thus gives an even stronger competitive advantage regarding the energy potential of organic combustibles.

The area of palm oil plantations in Cameroon is still quite small compared to countries leading in palm oil production, such as Indonesia and Malaysia (Hoyle and Levang 2012). However, the growth trend of the palm oil industry in Cameroon promises an increase in biomass accumulation on plantations leading to a higher availability of residues suitable for energy generation in the future. This trend is supported by increasing regulations preventing the clearing of forests such as the Reduced Emissions from Deforestation and Degradation (REDD) mechanism becoming more active in the leading palm oil producing countries rather than in Africa (Hoyle and Levang 2012). A longer planting history and a higher total hectarage could make OPT available on a continuous basis. Whether such development is desirable from an environmental viewpoint, of course, is questionable.

14.3 Sustainability Aspects of Imported Solid Biofuels

Sustainable sourcing of solid biofuels addresses a wide range of criteria to be taken into account. According to the European Commission, efficiency of energy transformation, social aspects, the protection of ecosystems with a large biodiversity and high carbon stock, as well as the reduction of greenhouse gases, play an important role in this context. The “Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling” (further referred to as COM (2010)11), published by the European Commission in 2010, provides recommendations and guidelines for criteria for GHG emission reduction related to the use of solid biofuels. It states that biomass cannot be taken from protected nature reserves or primary forests. With reference to woody biomass, deforestation and extensive extraction of forestry residues shall be avoided. Moreover, there are potential conflicts with the food industry, crop prices, land use rights and national standards of labor. Specific on-site ecological problems concern soil fertility, as determined by nutrient content and biomass turnover in plantations ecosystems.

Furthermore, there is still a high potential of increasing the efficiency of energy transformation, especially for electricity and heat generation with woody biomass. The European Commission therefore recommends the promotion of combined heat and power systems (EC 2010). Consequently, important criteria for the evaluation of the sustainability of an energy carrier also lie in the energy generating technology applied to it, e.g. measured by energy and heat conversion rates. With reference to palm oil plantations, the Roundtable on Sustainable Palm Oil (RSPO) can serve as an example of how energy efficiency and renewable energy carriers can be covered by a sustainability standard (RSPO 2013). However, explicit requirements for the energetic use of plantation residues are still undefined.

As can be seen, independent of the claim to achieve sustainable bioenergy, some of the mentioned criteria can be considered as increasingly significant also for a holistic view on the sustainable management of palm oil plantations. At this point, a clear distinction between sustainability criteria for imported solid biofuels and for palm oil is necessary. However, the strong interrelation between agricultural production systems and raw material supply for renewable energy production, in this case palm oil production and the sourcing of organic residues for wood chip or pellet production, is apparent. Because of this, standard systems need to be assessed and compared from the perspective of both systems. Existing certification schemes for biomass production often overlap or apply to a specific production system, e.g. the Roundtable on Sustainable Biofuel (RSB) or the Better Sugar Cane Initiative (BSI). In forestry in particular, various voluntary certification systems exist for the proof of sustainability, e.g. the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) (IFEU 2011). The challenge is to further investigate whether the same standards can, if only partially, be applied to plantations as specific production systems and the residues accumulating on site. In the following, some case examples on sustainability aspects will be discussed in order to show the complexity of applications and interfaces between the different standards. Based on such considerations, the integration of criteria for the sustainable use of woody residues into existing VSS systems, whether in the context of palm oil or biofuel production, shall be achieved in the future.

14.3.1 Greenhouse Gas Emissions

Among many other sustainability aspects, the carbon footprint of importing woody biomass from tropical countries is the most important because it has a direct influence on the global climate. There is no justification for trading biomass for the production of ‘renewable’ energy if its entire life cycle turns out have a negative impact on the climate. According to the Intergovernmental Panel on Climate Change (IPCC), bioenergy has a significant GHG mitigation potential if resources are developed sustainably and efficient bioenergy systems are used. However, the net positive GHG reduction impact can be lessened by direct loss of carbon stocks and indirect land use change (ILUC) (Chum et al. 2011).

‘Carbon neutrality’ for bioenergy has been the presumption in many scientific concepts so far, which assumes that end-of-pipe emissions are automatically offset by regrowth of biomass. This characterisation generalises the GHG emission intensity of biomass use and leads to a problematic misrepresentation of the heterogeneity of biomass. The Institute for European Environmental Policy (IEEP) contests that through international trade of wood pellets, especially from the tropics, this form of bioenergy sourcing can no longer be considered as 'climate neutral'. It is thus unavoidable to assess the climate balance of the whole supply chain. Consequently, for every separate type of biomass import, a complete Life Cycle Assessment (LCA), an analysis of all fluxes of energy and material from production until disposal of a product, should be carried out as proposed by the EU (EC 2010). According to the IEEP (2012), however, many of the data used in LCAs are based on flawed life cycle metrics. The various supply chains of biomass exhibit a great variety with regard to their respective climate impact. Characteristics and conversion pathways through which biomass can be utilised lead to considerable variations of the emission intensities associated with the different feedstocks. This is because for biomass sources where carbon neutrality is presumed, the risk of underestimating emissions in accounting exercises can vary considerably. The greatest weaknesses have their origin in the assumptions underlying the life cycle calculations which have been largely adopted by EU bioenergy policies. Some of these errors can be the risk of underestimating or ignoring alternative uses, the need to replace nutrients or potential effects on soil productivity and soil carbon stocks (IEEP 2012).

It is often assumed that emissions associated with the combustion of bioenergy are automatically offset. In reality however, the extraction of biomass from its original source will inevitably lead to a temporary carbon imbalance on site. This amount can only be balanced in favor of the climate if the carbon content added to the total atmospheric carbon stock is compensated by the re-growth of oil palm biomass capturing carbon from the atmosphere. Nevertheless, COM(2010)11 determines that both for the firing of woody biomass in coal power plants within the emission trading scheme of the European Union and for biomass thermal power plants subsidised by the RED, GHG emissions are generally balanced 'zero' (EC 2010).

At the start of the life cycle of a biofuel, the energy consumed for the cultivation of raw biomass and the related GHG emissions are of particular importance. In order to comply with the requirement that no additional energy is consumed during cultivation, it is crucial that oil palm biomass does not lose its residual character as opposed to biomass exclusively cultivated for energetic purposes, such as short rotation coppice or other so-called 'energy-plants'. The advantage for the overall climate balance of residual wood is that calculations of GHG emissions only start at the point of biomass collection and extraction from the original production site, namely the plantation. The energetic use of plantation residues is linked to the already present expansion and intensification of oil palm cultivation, therefore indirect additional GHG emissions due to deforestation and land use change might have to be taken into account in the calculations. A clear definition of what is 'residual' biomass and how it can influence the development of the palm oil industry is thus necessary to be included in sustainability standards.

Moreover, the accounting exercise may ignore or underestimate the temporal dimension of decomposition or existing uses, or a so-called *counterfactual*. This is relevant, for example, if the cut or pruned oil palm biomass was otherwise oxidised immediately, as for site preparation through burning (IEEP 2012). Since there is no proof of effective residue management in many palm oil producing countries, it can be assumed that residues accumulating on palm oil plantations are usually left to decompose or burned on site, meaning a direct release of carbon into the atmosphere in the latter case. Oil palms store about 40 tonnes of carbon per hectare (UNEP 2012) which is released into the atmosphere when burned. Applied to the total area of palm oil plantations in Cameroon, one calculates around 7.8 million tonnes of carbon contained in oil palm biomass.

Against this background, alternative uses of residual biomass such as soil fertiliser (Choong 2012) or local applications of solid biofuels for cooking and heating can be preferable in terms of resource efficiency, climate impact or local socio-economic benefits. Especially in developing countries, the majority of the poorest households and small industries depend on the supply of woody biomass (Chum et al. 2011). Furthermore, forest residues are already being utilised in the wood panel or chemical industry. In many other cases, residues are relied upon in order to maintain carbon stores in managed forests or they are used as bedding or soil improver in agriculture (IEEP 2012). If such uses are not existent however, the exportation of solid biofuels produced from plantation residues can be considered as a means to reduce the overall (indirect) climate impact related to the palm oil industry.

From another perspective, the conventional use of fossil fuels constitutes an alternative to the option of co-firing which is even more harmful to the climate. From this viewpoint it is worth assessing the GHG emission reduction potential of pellets made from plantation residues destined in particular for substituting emission-intensive fossil fuels in existing coal power plants in Germany. Here, the blending share and the type of fossil fuel to be replaced also influence how climate-friendly the energetic use of solid biofuels is. For example, the specific emission reduction potential of substituting lignite is much higher than that of replacing hard coal because power generation from lignite involves much higher emissions (Vogel et al. 2011).

Concerning the origin of solid biofuels, the highest GHG reduction potential lies in the use of forestry residues from the EU in the form of wood chips or pellets; the latter only if wood is used as process fuel for pellet production. With these options, emission savings of more than 90 %, compared to fossil fuels, can be achieved for both electricity and heat generation (EC 2010). However, most national wood resources are limited for energetic applications, especially in Germany, due to the existing demand for wood for material use such as furniture or paper. An increase of energy production from woody biomass will depend on technology development and the access to additional sources of woody biomass (Vogel et al. 2011). Wood pellets imported from the tropics still bear an emission reduction potential of around 30–70 %, also depending on the process fuel. Using natural gas as process fuel reduces the GHG avoidance potential of wood pellets from both the EU and the tropics by a considerable amount. For example, GHG avoidance for wood pellets from the tropics is reduced by more than 50 % if natural gas instead of wood is used as process fuel for pellet production.

It becomes clear that a final judgment can only be made if a fair baseline for comparing the GHG emission intensity of different energy sources or uses of biomass is provided. For the application of sustainability standards to the energetic use of woody biomass, a highly-differentiated scale of emission profiles of alternative energy sources will be required to enable the comparison and sustainability evaluation of a single energy product. As an integral part of an LCA, a sustainability standard for imported solid biofuels should particularly account for the process fuel used in production, the type of fossil fuel which is substituted and the blending share of co-fired biomass since these factors have a major influence on an energy product's global GHG emission reduction potential.

Some voluntary certification schemes such as the Roundtable on Sustainable Biomaterials (RSB, formerly known as the Roundtable on Sustainable Biofuels) describe requirements for the certification of sustainable biofuels with regard to their contribution to climate change mitigation. Principle 3 requires biofuels to significantly reduce lifecycle GHG emissions (by 50 %) as compared to a fossil fuel reference. The RSB lifecycle GHG emissions calculation methodology includes emissions from land use change, carbon stock changes and gives incentives to use residues in a way that GHG emissions of the biofuel are reduced (RSB 2010). Another certification system for biomass from agriculture and forestry is the Green Gold Label (GGL) which covers all process steps beginning with cultivation until the final energetic or material use of biomass. A separate standard (GGLS8) determines aims and calculation methods in compliance with the EU described formula for GHG emission reduction. The GGL also defines an emission reduction by 50 % (GGL 2012).

Both the RSB and the GGL bear a relatively high potential of application to imported woody biofuels. The principles and criteria of the RSB have been adapted to be in agreement with the sustainability requirements of the EU-RED, including the calculation methodology of GHG. In Agriculture, Standard 2 of the GGL (GGLS2) is a widely accepted certificate (IFEU 2011) but it does not cover the criteria of GHG mitigation addressed by GGLS8. In contrast to the RSB, it only uses the EU-RED as orientation and does not consider the variety of indirect effects on the GHG balance of biofuels.

Most existing standards for sustainable biofuels require a clear understanding of the source, transportation and final use of the type of biomass under assessment in their principles. They often do not describe, however, additional factors influencing the overall emission profile, among which are, for example, negative consequences of biomass extraction through increased fertiliser use, which is known to be highly intensive in GHG emissions. The process fuel used for biofuel production or the type of fossil fuel replaced in the case of co-firing are also ignored in most cases. Eventually, the use of plantation residues for energy production can never be completely 'climate neutral'. The natural decay of biomass will always have a better climate balance than its use for co-firing in power plants with additional emissions through fuel production and transport. As a conclusion, a certain type of biofuel should always be certified only as ‘climate-friendly’ or relative to the available counterfactuals and not as ‘sustainable’ *per se*.

14.3.2 Ecological Impacts

As another crucial aspect of sustainability, the protection of ecosystems and biodiversity was mentioned. In most tropical countries, biodiversity loss and ecosystem disturbances are attributed to ongoing deforestation. Especially in developing countries, a reason among others is the absence or insufficiency of decision-making structures concerning the sustainable management of forest resources (EC 2010). This allows the continued expansion of palm oil plantations posing a direct threat to biodiversity through land conversion. As an example, recently planned plantation sites in Cameroon lie inside globally recognised biodiversity hotspots between protected areas (Hoyle and Levang 2012).

From an economic viewpoint, the possibility of additional market value for oil palm biomass can give further incentives to expand plantation areas independent of the already lucrative business of palm oil production. On the contrary, meeting the demand for bioenergy with residual wood from plantations instead of (primary) forests might help to combat extensive extraction of biomass from other sources with higher ecological and biological diversity. The energetic use of plantation residues might become an additional criterion for sustainable palm oil production since it can contribute to the reduction of overall GHG emissions within the entire production system.

The present problem of deforestation attributed to the extension of palm oil plantations has already been addressed by many initiatives, e.g. by the Roundtable on Sustainable Palm Oil (RSPO). One of its criteria (Principle 5) is the environmental responsibility and conservation of natural resources and biodiversity. The certification system explicitly requires that new plantations after 2005 shall not replace primary forests (Principle 7) (RSPO 2013).

The International Sustainability and Carbon Certification (ISCC) introduced in 2010 also define principles referring to the ecological impacts of biomass and bioenergy. It demands that biomass is not sourced from species-rich areas and those of high nature protection value and includes a criterion for sustainable agriculture with a special focus on water and soil quality (IFEU 2011).

As another crucial component of the sustainable management of biomass-producing ecosystems, soil quality and nutrient cycling play a major role. In many forests, the extraction of residues has beneficial effects on nutrient stocks, but only to a limited extent. An increasing demand for biomass residues, however, can cause losses to the soil carbon stock if too few residues are left on site (EC 2010). For some primary forestry and agricultural residues it may be better to keep the residual material in situ, helping to maintain soil carbon stock (IEEP 2012). Especially nutrient-poor soils rather benefit if residues are left where they accumulate (Flaig et al. 1999). In Malaysia, one of the major palm oil producing countries, studies on nutrient cycling and residue management have been carried out since 1994. The so-called ‘Zero Burning Technique’ involves the planting of oil palm seedlings into the rows of old palm biomass residues in order to conserve nutrients. It is described as the “most effective method of biomass management during replanting” because young palms can easily take up the nutrients released by chipped or shredded residues. The major benefits of this method are the conservation of soil fertility through nutrient recycling and moisture conservation, as well as the maintenance of biodiversity of soil fauna and microbial communities (Khalid et al. 2007).

Another positive side-effect also with regard to the energy and GHG emission intensity of palm oil production is the reduction of chemical fertiliser input to 50 % (Khalid et al. 2007). Total estimated emissions related to the life cycle of fertiliser accounts for around 2.5 % of total global GHG emissions (IFA 2009). Against this background, innovative residue management on oil palm plantations does not only reduce spending on fertiliser, but also the environmental impact of fertiliser production and use, without expanding the area under agricultural production in order to maintain yields. The returning of nutrient-rich ashes after combustion is another alternative method to maintain soil fertility. This idea, however, seems too unrealistic for long-distance biotrade as in the case of Cameroon which makes the returning of ashes economically inefficient and thus undesirable.

Many standard systems are limited with regard to the effect of energetic use of residues on plantation ecosystems. As stated before, a holistic understanding of sustainable palm oil production should integrate the sustainable use of residual biomass not only with regard to its climate impact and its energetic potential, but also it’s potential as soil fertiliser. The extraction of woody biomass for energetic use can compete with the sustainable management of plantation residues from an environmental viewpoint. Therefore, the local use of plantation residues as a nutrient source should be outweighed against its energetic use in terms of costs, energy consumption and GHG emissions along the entire life cycle of the product.

To give an example, one principle of the Roundtable on Sustainable Biomaterials (RSB) is the requirement that biofuel operations shall apply practices that help to reverse soil degradation and protect soil quality (IFEU 2011). The intensive extraction of residual biomass on palm oil plantations could severely lower the soil’s nutrient content. If the production of woody biofuels from plantation residues can be defined or interpreted as such operation, there is no hindrance for the application of such criteria to this specific case.

With regard to palm oil plantations, the RSPO has formulated a principle for appropriate best practices by growers and millers (Principle 4). Criterion 4.2 requires practices which maintain soil fertility “at a level that ensures optimal and sustained yield” (RSPO 2013). It further explicitly states that nutrient recycling strategies should include empty fruit bunches (EFB), palm oil mill effluent (POME) and palm residues after replanting and any of its use for energy production (RSPO 2013). To which type of energy conversion pathway should priority be given however, is not defined. Nevertheless, it becomes clear that the RSPO acknowledges the nutritional and energetic potential of oil palm residues and requires the avoidance of fire and residue burning for land preparation (Criterion 5.5) as it goes along with unnecessary environmental pollution (RSPO 2013). The recognition of utilising by-products for added value will be essential for certifying the sustainability of palm oil biomass energy products and at the same time benefit the sustainability of palm oil production (NL Agency 2013).

14.3.3 Socio-Economic Aspects

In many regions of this planet, biomass potentials are left unused or used inefficiently. In Africa, local uses of biomass as an important traditional source of energy in the rural areas are prevailing, but there is still a surplus. In 2009, 20 % of biogenic solid fuels are used in Africa and the majority (80 %) is used by the poorer population for meeting daily energy demands, e.g. heating and cooking (Kaltschmitt et al. 2009).

Due to the lack of access to modern technologies, however, the combustion efficiency of traditional open fires and simple stoves is usually low. A more efficient energetic use of woody biomass by the local population can be achieved through improved cookstoves (ICS) and other advanced biomass systems for cooking (Chum et al. 2011). The local use of refined biomass as fuel for households in the country where biomass is produced, e.g. in the form of wood chips or pellets, presents a promising alternative to biomass exports. It can help meet the energy demand of the local population in a more efficient way while reducing the dependence on fossil fuel imports and adds value to the local and national economy. Individual local added value can further lead to an improvement of the financial situation of individual plantation owners. From a microeconomic perspective, the sales of palm oil plantation residues provide the opportunity for an extra income for local oil palm cultivators. Small-holders might especially benefit from a higher profit margin than large agribusinesses, directly passing on additional incomes to their families. In general, a stronger relationship between owner and property, e.g. plantation residues as a potential source of bioenergy, yields a better understanding of production processes and consequently a stronger interest to protect and sustain them. In this way, uncontrolled and inefficient uses of biomass by burning or decomposition can be avoided. According to the principle that ownership entails obligation, the chances of illegal use of residual biomass can be reduced. Positive impacts of introducing pellet production in Cameroon in general are additional employment, revenue to the state and infrastructure expansion. In the long run, a sub-industry of residue processing associated with oil palm cultivation and palm oil production can develop over time, achieving economic development and labor opportunities in the region.

For future developments of bioenergy systems, trade-offs between environmental and socio-economic criteria need to be taken into account. With regard to the climate impact of imported solid biofuels, the optimal scenario would be the local use of bioenergy, given that logistics are a major emitter of GHG along the supply chain. However, this option has been shown to be less promising than international biomass transports despite energy consumption and emissions caused by sea transport over large distances. The comparison of various bioenergy systems has proven that international compared to local utilisation of biomass has a higher overall reduction potential of GHG emissions (Uasuf 2010). As a consequence, a judgement on the sustainability of the energetic use of plantation residues depends on whether the focus lies on its climate impact or on socio-economic benefits to local economies. Eventually, those aspects prioritised by a specific sustainability standard will determine whether the type of biomass under assessment should rather be used locally or traded internationally.

Closely linked to the criteria related to the social and economic impacts of the palm oil industry and bioenergy production in developing countries, sustainable residue management and its processing should undergo similar treatment by the respective standards. A current issue, for example, is the fact that large agribusinesses usually seek large tracts of land and do not involve smallholders in their projects (Hoyle and Levang 2012). It is likely that residue extraction will take place most efficiently in areas where large-scale oil palm cultivation takes place thanks to existing management structures and economies of scale. Government support of industrial palm oil production, as in the case of Cameroon, could strengthen the position of agribusinesses investing in the trade or energetic use of residual biomass. As an important criterion for both sustainable bioenergy and palm oil production, the treatment of plantation residues as an integrated part of agricultural management needs to be carried out in a way that is smallholder-friendly and maximises economic efficiency with special focus on local added value. Social aspects referring to land use rights and living conditions of the local population have been adopted partly by the RED, but more comprehensively by the RSB, SAN and RSPO (IFEU 2011).

The RSPO is continuously developing detailed guidance for the application of its principles and criteria by smallholders which supports them in the certification procedure. However, it does not identify residue management and bioenergy production as a crucial socio-economic factor for rural development, an aspect which might have to be included in the future in order to further strengthen the position of smallholders (RSPO 2013). The Sustainable Agriculture Network Standard (SAN), linked to the Rainforest Alliance in contrast includes as a critical criterion that farm management must “implement policies and procedures for identifying and considering the interest of local populations and community interest groups” (SAN 2010). As part of Principle 7 on community relations, the standard requires the certified farm to collaborate with the development of the local economy and infrastructure (SAN 2010). Given that oil palm biomass is a resource with increasing economic value, the extraction of plantation residues in this context could be considered a new farm activity with a potential to have an impact on employment and local resource economy, as described in the principle. At this point, a clearer definition of such activities would help to identify the energetic use of residual biomass among other measures which influence the social and economic wellbeing of local communities.

14.4 Conclusions and Recommendations

Given the increasing amounts of solid residues on oil palm plantations and the high energetic potential of the accumulating organic matter, the production of solid biofuels from such raw materials becomes increasingly relevant for environmental, social and economic considerations. As for the case of palm oil production, for credible certification of sustainable production of biofuel from solid organic matter, all aspects of sustainability need to be addressed. Especially the GHG emission balance of exported solid biofuels, impacts on biodiversity through direct and indirect land use change as well as soil fertility deserve particular attention. When it comes to socio-economic considerations, sustainability standards should take into account the smallholder-friendliness of its application. Stable and reliable energetic use of solid biomass on this scale appears to be of higher significance to traditional agricultural structures, especially for the poorer share of the population.

Concerning the sustainability of biofuels produced from plantation residues, its local use is recommendable in order to reduce the climate impact attributed to the logistics phase of imported biofuels. Nevertheless, the co-firing of imported wood pellets produced from plantation residues in developing countries reveals a much more climate-friendly emission profile compared to the business-as-usual combustion of fossil fuels. In general, the international aim of GHG emission reduction should always be viewed from a global perspective rather than a local one because climate warming affects the whole planet. However, local efforts can help achieve this global aim, and bioenergy systems applied close to the sites where raw material is supplied should be given priority provided that they show a better climate balance relative to international trade of biofuels. Against this background, one of the most important principles of sustainable biofuels will be a clearly defined method of GHG life cycle calculations. The calculation methods described by most standards addressing the reduction of GHG emissions, including RSB, ISCC and GGL, refer to the RED by the European Commission. For the correct allocation of GHG emissions, all of the mentioned standards can thus be referred to when the certification of imported biofuels is at stake. However, as emphasised before, remaining errors in the method of calculation and estimations proposed by the EU should be removed, taking into account further parameters such as the carbon intensity of existing uses, long-term soil carbon stock and the temporal dimensions of biomass production and biofuel use.

The trend of expanding palm oil plantations in developing countries such as Cameroon is apparent and implies ecological problems related to indirect land use change and biodiversity loss through deforestation. The impact of biomass extraction on soil quality and thus long-term productivity of palm oil plantations is still vague or considered irrelevant. Woody biomass loses its residual character if its energetic use competes with local, innovative residue management techniques which aim to maintain the nutrient balance in soils. The efficient use of residues for the purpose of soil fertility conservation should thus have priority over any other alternative usage and should be a component of any standard system certifying sustainable palm oil production such as proposed, to a limited extent, by the RSPO. A measure against the ongoing deforestation of primary rainforests and deteriorating soil health could be in the form of maximum extraction limits of residual woody biomass for any purpose other than soil fertiliser. The reduction of soil carbon through extensive use of woody residues is dealt with for example by the RSB, but it does not consider the nutrients contained in the residues (IFEU 2011). Consequently, a high potential of developing the component of soil protection for the standardisation of sustainable biofuels made from plantation residues remains. From an environmentalist perspective, the extraction of biomass from the site of its initial growth should be avoided for the simple reason that all human interference in plant ecosystems can disturb its carbon and nutrient balance in soils. The term *sustainability* of solid biofuels should thus always be used in a relative and cautious manner.

From a socio-economic viewpoint, many principles on the valorisation of labour and land use rights, business transparency, standards of living and the interests of the local population are included in many existing standards, e.g. the RSB, ISCC, FSC, SAN and RSPO (IFEU 2011). They do not require further extension in order to be applicable to the production of bioenergy from organic residues. However, the scope of application of the sustainability criteria suggested by COM(2010)11 for standard systems should also cover small-scale users of biomass when applied to developing countries despite the additional administrative burden. The production and use of certified solid biofuels could add value to local economic entities and encourage higher performance and efficiency for those who depend on local biomass sources the most. From another perspective, the certification of biofuels imported from developing countries should also involve an assessment of competing, economically more sustainable uses of biofuels on smaller local scales.

For any sustainability standard addressing the use of woody biomass as a source of energy, a transparent, non-confusing and open communication to consumers of which aspects are covered by a single certificate is of superior necessity. One needs not forget that there is a vast range of existing certification schemes which go far beyond those mentioned in this chapter. It is therefore recommendable that new subjects affected by the international discussion about the sustainable production of biofuel, respectively palm oil, are included in highly-developed and established standard systems already addressing similar products or production systems. With regard to the issue of deforestation, a final challenge will be the social acceptance of palm oil in general and bioenergy imports especially from tropical countries, which is independent of a specific sustainability standard. Eventually, the certification of imported energy carriers produced from woody residues as well as products containing sustainable palm oil requires, as in many similar cases, accurate and factual information accessible to the end user in order to achieve acceptance and consequently market access.

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